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To: Patricia Francis, Ithaca New York
From: Alex Horne
Re: Cauyga Lake & Cornell University Cooling System using lake water
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SUMMARY

A major purpose of a draft EIR is full coverage the potential impacts of the project and there should be no substantial omissions of fact. While the draft EIR does cover many aspects of the project on Cayuga Lake, it is my opinion that several areas of concern to most lake users are omitted. Many features of the inevitable eutrophication of the lake are totally ignored. The southern portion of Cayuga Lake currently has relatively poor water quality and there is no margin for further nutrient pollution without serious effects. The LSC project will inevitably cause undesirable eutrophication and this is not properly covered in the EIR and no mitigation is offered.

Blue-green algae increase. The first omission is that draft EIR makes no mention that the Lake System Cooling (LSC) project will cause or increase nuisance blooms of blue-green algae (cyanobacteria), which could cover several miles of near shore water in summer. Release of large volumes of nutrient-rich water will, by definition, cause eutrophication in the shallow southern area of the lake near the shallow water discharge. This area is already above the NYSDEC standards for total phosphorous. Total algae as measured by chlorophyll a is already high, water transparency is poor, nitrate is very high, and the likelihood of increased nuisance blooms of blue-green algae in this region were not mentioned in the draft EIR. Near-surface discharge of bioavailable nutrients sucked up from deep water will inevitably worsen the situation.

Over reliance on math models. The draft EIR relies almost entirely on a mathematical model supported by a very limited field-monitoring program. In other projects of this kind in which I have been involved an equal amount of time and money as was spent on models or field monitoring was spent on experimental measurements of lake effects. In particular, actual measurements of the production and kinds of algae produced by the waste were carried out in the lake and in the laboratory. In this way some more direct prediction of effects can be made instead of complete reliance on a mathematical model. Complex lake models are excellent tools for relative differences between project options, but are less useful in providing reliable absolute numbers and at predicting specific biological responses.

Underestimation of eutrophication. The eutrophication potential is underestimated in the draft EIR due to the method used to estimate the percentage increase in phosphorus, the algal growth-limiting nutrient in this lake. Underestimation of phosphorous automatically underestimates the amount of algae that will grow as a result of the project. The draft EIR states that the LSC project will increase total phosphorous (TP) in the area by an "insignificant" 3-7%. The draft EIR omits the fact that this calculation is based on using a very large area of the lake as a dilution basin. If a more reasonable local area of the southern basin had been used based on the plume model in the draft EIR, the LSC's percentage would rise by a factor of five. The other reason the draft EIR can claim that the LSC project has a small impact is that it ignores likely future reductions in TP loading other from other sources such as city sewage plants. If both of these factors are considered, the contribution of the LSC project to the future TP budget of the area can rise to 30% and may exceed 50% in dry years. Such an increase would definitely be significant and must be considered and mitigated in the draft EIR. In addition, the bioavailable phosphorus added by the LSC will not be physically diluted: it will be quickly taken up by algae and used for growth.

Underestimation of algae produced. The draft EIR makes several assumptions about the conversion of TP to algae, the amount of algae that will be produced in a given area, that considerably underestimate the amount of algae that will be produced. Alternate assumptions show that instead of increasing algae by only 2.5 ug/L (as chlorophyll a, draft EIR p. 2.3.3-25) over the summer, the LSC will actually increase the concentration to 40 ug/L above the current 6-8 ug/L – a huge increase in the local region of the discharge plume. The draft EIR also totally neglects the surface drifting ability of blue-green algae. Adding feasible horizontal drift to the amount of algae produced in the LSC plume could lead to dense local accumulations of blue-green algae that could shut down drinking water systems for weeks, kill livestock and pets that drink lake water and produce odors that would close beaches and shoreline cottages. These effects would only occur irregularly and not always at the same place but other lake users have found them intolerable. This aspect of lake eutrophication should be described and mitigation determined.

Pipe fouling effects. The draft EIR does not consider the effect on the lake of the organic and bacterial loads that occur following any type of inlet and outlet pipe cleaning. Cleaning with physical methods involved discharging millions of fragmented zebra mussels and other fouling organisms. In addition, there are potential toxic effects since the proposed physical cleaning method may not work. Mussels and other fouling organisms have been difficult to other piping systems and the draft EIR does not consider alternative mechanisms to prevent fouling. A common reliable method for removing pipe fouling is regular static chlorine addition. This would provide quite a toxic problem in this lake but is not addressed in the draft EIR. There was also no consideration of an chronic or acute leaks the heat exchanger system. This problem, the pollution of the once-through cooling water by toxic slimicides and heavy metals in the continually circulating water system has proven very difficult to cure in other projects and is not addressed in the draft EIR

Temperature shock and ice reduction. Also omitted is the short-term temperature shock and buffeting that will be experienced by billions of entrained shallow water zooplankton each day almost certainly resulting in their death. The effect on ice reduction in the outflow area was not backed up by data

For the above reasons, the draft EIR should be rejected until such time as the full impacts of the LSC are considered. In particular, the eutrophication caused by a major nutrient discharge into a sensitive area must be described in terms of increases in nuisance blue-green algae. In addition, serious attention should be given to toxicity and pollution due to the current pipe design and maintenance.

INTRODUCTION

I have reviewed the entire document "Draft Environmental Impact Statement – Lake Source Cooling Project: Cornell University". In addition I have used various other publicly available publication and texts on Lake Cayuga and the other New York Finger Lakes. The "Draft Environmental Impact Statement – Lake Source Cooling Project: Cornell University" is intended to cover all the effects of a large-scale cooling water extraction and return from Cayuga Lake, one of the New York Finger Lakes. The Draft EIR covers many aspects of the project but I will restrict my comments to the area of the effects of the proposed cooling system on the lake ecosystem. In particular, I comment on the chemical and biological effects.

The effects of the LSC on the limnology of Cayuga Lake are divided into those affecting the physical, chemical, and biological aspects. Most attention in the draft EIR was paid to the physical effect, no concern was paid to chemical toxicity and pipe fouling. Biostimulation models and mysid shrimp were the main biological concerns of the EIR. In most cases, a sufficiently complete data set and discussions were available in the draft EIR for me to draw conclusions without the need for much additional information.

My qualifications as a reviewer for this project are that I have carried out research on the effects of nutrients on aquatic ecosystems on all five continents beginning in 1964. I have been a professor of Ecological Engineering teaching and researching lakes and other water bodies since 1971 at the University of California at Berkeley (see attached resume). I have written the best selling undergraduate textbook on limnology (the study of lakes) and have published 178 research papers and articles in the fields of pure and applied limnology and oceanography. I have been involved in the writing and research needed for dozens of EIRs in the US and elsewhere. In terms of cooling systems, I teach thermal pollution as part of my courses and have spent several years carrying out research on all the effects of very large ocean cooling systems for the Federal Ocean Thermal Energy Conservation (OTEC) Program. The OTEC projects were almost identical to the proposed LSC project in that both involved bringing up large volumes of nutrient-rich deep water in large pipes and releasing it on the surface. Over the years of our research in the 1980s we found that major environmental concerns were the biostimulation caused by the upwelled nutrients and the incidental toxicity produced by pipe cleaning and leaks in the various cooling fluid exchange systems.

CRITIQUE OF THE DRAFT EIR

EUTROPHICATION POTENTIAL OF THE LSC PROJECT

Probably the most important environmental effect of the upwelling of cool deep and nutrient rich water is the threat of eutrophication. Lakes are classified into productive (eutrophic), unproductive (oligotrophic), or in-between (mesotrophic). In general, oligotrophic lakes are the most preferred by human users and Cayuga Lake was probably completely oligotrophic 200 years ago. Eutrophication is the process whereby addition of inorganic nutrients to a lake causes an increase in algae. Undesirable scums of blue-green (cyanobacteria) are characteristic of eutrophic lakes as are decreases in water clarity. Blue-green algae produce many other undesirable effects including taste and odor in drinking water supplies as well as organic chemicals that are highly toxic to wildlife and humans alike.

Most of Cayuga Lake contains clear unpolluted water free from large growths of algae. The southern end of the lake is no longer in this condition and has no ability to accommodate further pollution. The southernmost portion of Cayuga Lake is already technically either eutrophic or mesotrophic depending on the indices uses (Table 1). The proposed LSC outfall is in the most degraded area of Cayuga Lake which is currently in a very ecological delicate balance and not likely to withstand increases in nutrients without exacerbating water quality problems.

Table 1. Trophic state of Cayuga Lake in the southern part near the intended LSC outfall. This section of the lake is either over or very close to the mesotrophic-eutrophic border and will not accommodate the LSC nutrient addition without becoming more eutrophic. Most water uses are incompatible with a eutrophic lake which is thus undesirable. Cayuga Lake data is from the draft EIR, other values are typical of those found in the published literature and were formed by averaging many published values. TP = total phosphorous, TN = total nitrogen, Chl a = chlorophyll a, the green pigment use to approximate algal biomass. Secchi depth is a measurement of water clarity that indicates how deep in the water column a white disc can be seen.

Trophic parameter	Near proposed outfall Sta # P2	Typical eutrophic lake	Typical mesotrophic lake	Mesotrophic-oligotrophic border
TP (ug/L)	24-31	42	20	31.5
TN (ug/L)	1,200	1875	753	
Chl a (ug/L)	6.8-8.9	19.4	6.9	7.9
Secchi depth (m)	1.5-1.9 m	1.4	3.4	2.6

Current violations of the NYSDEC guidelines for TP in the LSC discharge area. The area of Cayuga Lake close to the proposed outfall is already above the guideline or 20 ug/L for TP proposed by the State DEC (Table 1). Average summer values for 1994-94 TP of 24-30 ug/L are given in the draft EIR (Table 2.3.3-14). Unaccountably the draft EIR considers 24-30 ug/L to be less than this guideline of 20 ug/L. The EIR states "... data indicate that southern Cayuga Lake currently meets the ambient water quality guidance value for TP in ponded waters since the summer average concentration is consistently below 20 ug/L)." (p 2.3.3-21). A similar statement "Note that Cayuga Lake meets the NYSDEC TP guidance value or 20 ug/L." (p. 2.3.3-5). The only explanation for the discrepancy is that the draft EIR considers the entire lake or at least all of the southern lake as a dilution field for its waste effluent, which is neither realistic nor appropriate. The actual discharge will take place in a region of the lake where the guidance value was already consistently exceeded by an average of 34% (range 19 – 54%, summer averages 1994-96, taken from draft EIR table 2.3.3-14). The misuse of the dilution field is discussed below. The reliance on TP rather than a more robust indicator such as chlorophyll a or algal species is also discussed below.

DRAFT EIR'S OVER-RELIANCE ON DILUTION TO REDUCE EUTROPHICATION EFFECTS

The draft EIR's conclusion that there will be no significant effect on the physical, chemical and biological aspects of the Lake Cayuga depends to a large part on dilution of the LSC effluent with large volumes of other, cleaner water. Another unsupported assumption is that the discharge of bioavailable phosphorus will be physically diluted to background levels and thus have no effect.

Choice of area for dilution of the effluent plume. In terms of physical dilution the draft EIR findings of no significant effect depends entirely on the volume or area of lake chosen to dilute the effluent. The draft EIR chooses the entire lake area south of Myers Point as the boundary for dilution water (Chap 2, p. 2.3.3-25). However, based on the draft EIR model of the effluent plume, the area chosen could equally well be the area south of Portland Point and half water across the lake. If this alternative were used, the plume of increased phosphorus would have five times less dilution and the effect would become significant.

My choice of a smaller volume relative to that shown in the draft EIR is not incompatible with the lake's physical limnology. For example, the draft EIR model of the discharge shows a long plume of nutrient-polluted water is show stretching for over four miles along the eastern shore of the lake (Fig. 2.3.3-8D). The water in the plume is obviously not mixing equally throughout the entire southern basin of the lake south of Myers Point as stated in the draft EIR calculation of dilution (Chap 2, p. 2.3.3-25). Thus the draft EIR's use of larger volumes for dilution of the added phosphorus is not appropriate to calculate the percentage effect of discharge from the LSC. The resulting higher percentage of effect of added phosphorus given using the smaller and more realistic plume results indicates that the effect of the nutrient additions are significant to the draft EIR's conclusions and should be reduced or mitigated.

Appropriate time scales for calculation of dilution fields. The correct time scale is important for the calculation of the dilution field. Eventually, most of the discharge will mix through most of the volume of the entire Cayuga Lake. Neither the author's of the draft EIR nor I consider the entire lake the appropriate volume for nutrient dilution. The draft EIR chooses the entire southern section; my own choice would be the plume bounded by some dilution such as that shown in the draft EIR fig 2.3.3-8D. In this figure, the boundary of an increase of 0.1 ug/L TP is shown as a plume extending for over four miles along the eastern boundary. The time taken for this plume to form is not shown but it is the order of hours or days not months.

Phytoplankton takes up phosphorus in a few minutes or hours and can store it for later use in special cell inclusions called poly-phosphate granules. Up to 20 times the amount needed for growth can be stored in this way which means that algae need only a short exposure to take up the phosphorus for later growth. Thus the dilution of phosphate assumed by the LSC EIR model is not appropriate. The phosphorus will not be diluted to insignificant levels. It will be mostly taken up quickly by algae and use for growth downstream and in other areas where the algae accumulate.

EIR's Underestimate of Effects of Phosphorus of Lake Eutrophication

The main impacts of the LSC are that in summer, relatively high nutrient content water will be brought up from the hypolimnion and released into shallow, nutrient-depleted epilimnion water. Chapter 2 in the draft EIR discusses the effect of the phosphorus component of hypolimnion deep water on algal growth and other algal-related effects in the epilimnion. My budget does not allow me scope to check the complex model calculations, references or assumptions made in the draft EIR with regard to algal biostimulation. However, that is not needed at this stage as the author's of the draft EIR clearly state concentrations, assumptions, and methods used to estimate the magnitude of biostimulation. The concern for the lake is that an increase in TP of 3-7% is not considered significant by the draft EIR's authors. There is a case to the contrary to be made that the effect on eutrophication is in fact very significant, can produce significant side effects, and can be easily mitigated.

Postulate in the draft EIR. The draft EIR makes the argument that a 3-7% increase in TP per month (p. 2.3.3-17) is a small change and would be undetectable against the natural fluctuations in nutrients expected in such a large lake.

Response:

1. First if the argument that a small monthly percentage increase is insignificant was used, every waste treatment plant around the lake would be able to expand with no increased treatment so long as each increment was less than say 10%. The current trend in enclosed water bodies is to use a total maximum daily load (TMDL). Thus the increase from the LSC would increase the internal TMDL on the lake, which is already in critical condition. Any effects of increases in TMDL should be mitigated.
2. Second, the percentage is only as small as 3-7% because of the very large contribution of soluble phosphate from the City of Ithaca waste treatment plant and other smaller plants. If these were treated to the maximum feasible level (50ug/L TP), the contribution of the LSC would increase to over 30% in normal years and over 50% in dry years. These presumably would be considered significant effects. It is reasonable for a project with a 20-40 years or more lifetime that the expected

improvements in local wastewater treatment would not be negated by the LSC nutrient additions to the shallow water area.

3. The eutrophication argument proposed in #2 is not trivial. The health of Cayuga Lake with regard to eutrophication is not good. The lake is already considerably polluted with nitrate (concentrations ~ 1,200 ug/L). As recently as 1994 TP concentrations in the surface water in the south section were over 30 ug/L and Secchi depths were well below the warning level of 2m. These approaching or include eutrophic conditions that are not desirable in a drinking water and water contact lake.
4. The increase is small only when considered over a large part of the lake. In the several miles the plume is likely to affect the change is much larger (see early discussion).

LACK OF MORE ROBUST INDICATORS OF EUTROPHICATION SUCH AS CHLOROPHYLL AND ALGAE TYPE

Chlorophyll a increases due to the discharge. Phosphorus is a cause of impairment of lake designated uses but, by itself, is not a problem. The use of TP as an indicator is that it only indirectly indicates the actual impairment of the lake. Two of the most likely problems that will occur as the LSC project causes lake eutrophication are increases in total algae and the occurrence or increase in nuisance blue-green algae. The first item is lightly covered in the draft EIR where a calculated prediction of chlorophyll is made assuming all TP produced by the LSC project were converted to algae (p. 2.3.3-24). This is a conservative assumption but the draft EIR uses a TP:Chl a ratio of 1:1 (p. 2.3.3-24) and quotes at literature range of 0.5 – 2.0. This ratio was not measured as part of the draft EIR and so there is no good reason to suppose that the extreme part of the ratio could apply in the southern end of Cayuga Lake. If this were so, the amount of algae produced per TP would double.

In addition, a very large dilution volume of the entire southern basin (20 million m^3) was used to show a small overall effect despite the fact that the LSC model predicts that the effect would occur in a very much smaller area. The use of the area of the plume indicated in Fig. 2.3.3-6D would show an increase would be many times higher than that predicted in the draft EIR. I do not have the model to give me the most precise figures but using the same assumption as the EIR for dilution (p. 2.3.3.-24) I calculate that the chlorophyll would be spread over about 5 km^2 at most. Thus the actual chlorophyll would be about four times that calculated in the draft EIR.

The draft EIR indicates an average of 2.5 ug/L cumulative increase (range 1.25-5 ug/L) for June-October using the entire southern lake epilimnion (20 million m^3) as a dilution zone (p. 2.3.3-25). If the limit of the range of TP:chl a used in the draft EIR were used, these values could increase chlorophyll a to 10 ug/L cumulative for the summer season. Using the more conservative dilution indicated above the chlorophyll would increase a further four times to 40 ug/L. This is more than five times the average found for the discharge area in the 1994-96 summer monitoring.